

		<i>Parameter</i>	<i>Modification</i>	<i>Limit</i>	
SAR	Parameter	1	RF Pulse Type	Low SAR Mode	Manufacturer Options
		2	Concatenations	Increase	<2x exam Time
		3	Turbo Factor	Reduce	<2x exam Time
		4	Repetition Time (TR)	Increase	Weighting, Time
		5	Flip Angle (FA)	Reduce	Contrast, Signal
		6	Slice Number	Reduce	<2x exam Time
Scan Time	Parameter	1	Averages	Reduce	<2x exam Time
		2	Phase Oversampling	Reduce	40% Reduction
		3	Parallel Imaging	Increase	3x Acceleration
		4	Phase Resolution	Reduce	½ Original Resolution

SUPPLEMENTAL TABLE 1. Parameters used for modifying sequences to reach a given SAR limit.

		HEAD					
		<i>T1 SE Sag</i>	<i>T1 SE Cor</i>	<i>T2 TSE Ax</i>	<i>T2 TSE DF Ax</i>	<i>Diffusion Ax</i>	<i>TOF Ax</i>
RF Pulse Type	<i>SAR_{RT}</i>	Normal	Normal	Normal	Normal	Normal	-
	<i>SAR_{LOW}</i>	Fast**	Low SAR	Low SAR	Low SAR	Low SAR	-
Concatenations	<i>SAR_{RT}</i>	1	1	2	2	1	4
	<i>SAR_{LOW}</i>	1**	3	4			
Turbo Factor	<i>SAR_{RT}</i>	-	-	17	16	-	-
	<i>SAR_{LOW}</i>	28**			14		
TR	<i>SAR_{RT}</i>	550	550	4000	9000	4300	23
	<i>SAR_{LOW}</i>	1240**	650	6000	13000	5000	50
Flip Angle	<i>SAR_{RT}</i>	90	90	150	150	-	25
	<i>SAR_{LOW}</i>	15**	70	120	120		20
Slice Number	<i>SAR_{RT}</i>	25	30	25	25	25	40
	<i>SAR_{LOW}</i>	26**	15*				
Averages	<i>SAR_{RT}</i>	1	1	3	1	3	1
	<i>SAR_{LOW}</i>	1**		1			
Phase Oversampling	<i>SAR_{RT}</i>	30	-	-	-	-	-
	<i>SAR_{LOW}</i>	30**					
Parallel imaging	<i>SAR_{RT}</i>	-	-	GRAPPA 2	-	GRAPPA 2	GRAPPA 2
	<i>SAR_{LOW}</i>	GRAPPA 2**			GRAPPA 2		
Phase Resolution	<i>SAR_{RT}</i>	80	80	85	75	100	94
	<i>SAR_{LOW}</i>	80**	67	70	70		70
Scan Time	<i>SAR_{RT}</i>	03:07	02:24	03:46	04:32	01:06	04:38
	<i>SAR_{LOW}</i>	03:43**	04:31*	03:38	03:56	01:17	05:30

Note: *: Sequence was separated in 2 parts

-: Parameters not applicable in the sequence

~: Sequence was not able to be optimized for the SAR limit

** : Sequence changed

SUPPLEMENTAL TABLE 2. Parameter values per sequence for standard (*SAR_{RT}*) and low-SAR (*SAR_{LOW}*) protocols for the head anatomical region.

C-SPINE

		T2 TSE Sag	T2 TSE STIR Sag	T1 TSE Sag	T1 TSE DF Sag	T2 TSE Ax	T2 SSFP- 3D AX
RF Pulse Type	<i>SAR_{RT}</i>	Normal	Fast	Normal	Normal	Normal	Normal
	<i>SAR_{LOW}</i>	Low SAR	Low SAR	Low SAR	Low SAR	Low SAR	Low SAR
Concatenations	<i>SAR_{RT}</i>	1	1	1	2	1	-
	<i>SAR_{LOW}</i>	2	3	4	3	3	-
Turbo Factor	<i>SAR_{RT}</i>	18	9	3	6	13	-
	<i>SAR_{LOW}</i>	14	9	4	5	8	-
TR	<i>SAR_{RT}</i>	3800	3800	550	1900	5000	5.1
	<i>SAR_{LOW}</i>	6500	3800	600	2000	6500	7.6
Flip Angle	<i>SAR_{RT}</i>	150	150	150	150	150	63
	<i>SAR_{LOW}</i>	120		135	135		55
Slice Number	<i>SAR_{RT}</i>	15	15	15	15	28	56
	<i>SAR_{LOW}</i>						
Averages	<i>SAR_{RT}</i>	2	2	3	1	2	1
	<i>SAR_{LOW}</i>	1	1	1		1	
Phase Oversampling	<i>SAR_{RT}</i>	65	80	80	80	65	50
	<i>SAR_{LOW}</i>					70	
Parallel imaging	<i>SAR_{RT}</i>	GRAPPA 2	GRAPPA 2	-	-	-	-
	<i>SAR_{LOW}</i>				GRAPPA 2		
Phase Resolution	<i>SAR_{RT}</i>	100	75	70	90	80	100
	<i>SAR_{LOW}</i>	60				50	
Scan Time	<i>SAR_{RT}</i>	03:53	02:37	04:29	04:31	04:27	03:43
	<i>SAR_{LOW}</i>	03:30	04:12	04:54	04:32	04:15	05:31

Note: *: Sequence was separated in 2 parts

-: Parameters not applicable in the sequence

~: Sequence was not able to be optimized for the SAR limit

** : Sequence changed

SUPPLEMENTAL TABLE 3. Parameter values per sequence for standard (*SAR_{RT}*) and low-SAR (*SAR_{LOW}*) protocols for the C-spine anatomical region.

T-SPINE

		T2 TSE Sag	T2 TSE STIR Sag	T2 TSE DIXON Sag	T1 TSE Sag	T1 TSE DF Ax	T1 TSE Ax
RF Pulse Type	SAR _{RT}	Low SAR	Normal	Normal	Low SAR	Normal	Low SAR
	SAR _{LOW}		Low SAR	Low SAR		Low SAR	
Concatenations	SAR _{RT}	1	1	1	1	2	2
	SAR _{LOW}	5	2	2	5	5	9
Turbo Factor	SAR _{RT}	19	10	16	9	8	3
	SAR _{LOW}	14			4		
TR	SAR _{RT}	4000	4000	4000	650	1900	550
	SAR _{LOW}		4200		720		
Flip Angle	SAR _{RT}	150	150	150	150	150	150
	SAR _{LOW}	120	120	120	120	120	120
Slice Number	SAR _{RT}	15	15	15	15	15	25
	SAR _{LOW}		7*	7*	7*	7*	12*
Averages	SAR _{RT}	2	2	1	2	2	2
	SAR _{LOW}	1	1		1	1	1
Phase Oversampling	SAR _{RT}	100	80	90	80	80	50
	SAR _{LOW}	45	70	45	60	70	
Parallel imaging	SAR _{RT}	GRAPPA 2	GRAPPA 2	GRAPPA 2	-	GRAPPA 2	-
	SAR _{LOW}				GRAPPA 2		GRAPPA 2
Phase Resolution	SAR _{RT}	80	70	75	75	75	75
	SAR _{LOW}	65		70	65	68	
Scan Time	SAR _{RT}	02:52	03:40	02:30	03:50	04:30	03:36
	SAR _{LOW}	05:42	03:40*	03:38*	03:16*	04:56*	04:24*

Note: *: Sequence was separated in 2 parts

-: Parameters not applicable in the sequence

~: Sequence was not able to be optimized for the SAR limit

** : Sequence changed

SUPPLEMENTAL TABLE 4. Parameter values per sequence for standard (SAR_{RT}) and low-SAR (SAR_{LOW}) protocols for the T-spine anatomical region.

L-SPINE

		T2 TSE Sag	T2 TSE STIR Sag	T1 TSE Sag	T1 TSE Ax	T2 TSE Ax	T2 TSE MSMA Ax
RF Pulse Type	SAR _{RT}	Low SAR	Fast	Low SAR	Low SAR	Normal	Low SAR
	SAR _{LOW}		Low SAR			Low SAR	
Concatenations	SAR _{RT}	1	1	1	2	1	1
	SAR _{LOW}	4	3	4	8	4	4
Turbo Factor	SAR _{RT}	17	9	3	3	15	17
	SAR _{LOW}	9					
TR	SAR _{RT}	3500	3500	550	550	4000	4000
	SAR _{LOW}	4000	3600	600	600		
Flip Angle	SAR _{RT}	150	150	150	150	150	150
	SAR _{LOW}	120	120	120	120	120	120
Slice Number	SAR _{RT}	15	15	15	20	20	6
	SAR _{LOW}		8	8	10	10	3
Averages	SAR _{RT}	2	2	3	2	2	2
	SAR _{LOW}		1	1	1	1	1
Phase Oversampling	SAR _{RT}	80	80	80	30	40	20
	SAR _{LOW}	50					
Parallel imaging	SAR _{RT}	-	GRAPPA 2	-	-	-	-
	SAR _{LOW}	GRAPPA 2			GRAPPA 2	GRAPPA 2	GRAPPA 2
Phase Resolution	SAR _{RT}	70	80	70	85	75	80
	SAR _{LOW}	50					
Scan Time	SAR _{RT}	03:28	02:44	03:48	03:34	03:48	02:44
	SAR _{LOW}	05:06	04:10	04:52	04:11	04:18	02:58

Note: *: Sequence was separated in 2 parts

-: Parameters not applicable in the sequence

~: Sequence was not able to be optimized for the SAR limit

** : Sequence changed

SUPPLEMENTAL TABLE 5. Parameter values per sequence for standard (SAR_{RT}) and low-SAR (SAR_{LOW}) protocols for the T-spine anatomical region.

		SNR ROI1		SNR ROI2		CNR		PERCENTAGE CHANGE		
		SAR _{RT}	SAR _{LOW}	SAR _{RT}	SAR _{LOW}	SAR _{RT}	SAR _{LOW}	SNR ROI1	SNR ROI2	CNR
Head	T1 SE SAG	259.1	76.5	202.7	58.4	56.4	18.1	-70.5	-71.2	-67.9
	T1 SE COR	99.5	75.8	118.5	93.4	19.0	17.6	-23.8	-21.2	-7.4
	T2 TSE AX	34.3	31.9	31.7	24.5	2.6	7.5	-7.0	-22.8	182.4
	T2 TSE DF AX	68.7	46.6	101.5	70.6	32.8	24.0	-32.2	-30.5	-26.8
	DIFFUSION AX	95.8	89.3	105.3	102.0	9.5	12.7	-6.8	-3.2	33.6
	TOF	28.2	58.5	27.9	53.9	0.3	4.6	107.7	93.1	1686.3
C-spine	T2 TSE SAG	115.6	107.8	126.6	79.2	11.0	28.6	-6.7	-37.4	160.7
	T2 TSE STIR SAG	117.1	117.1	109.3	92.2	7.8	24.9	0.0	-15.7	219.2
	T1 TSE SAG	76.7	47.4	89.9	57.4	13.2	10.0	-38.1	-36.2	-24.6
	T1 TSE DF SAG	25.3	16.9	54.8	42.6	29.6	25.7	-33.3	-22.3	-13.0
	T2 TSE AX	133.9	111.5	94.7	62.1	39.2	49.4	-16.7	-34.4	26.0
	T2 SSFP-3D AX	11.4	8.4	12.9	13.2	1.5	4.8	-26.7	2.1	223.3
T-spine	T2 TSE SAG	92.4	88.4	38.3	31.4	54.1	57.0	-4.3	-18.1	5.4
	T2 TSE STIR SAG	79.9	82.2	48.5	34.4	31.3	47.7	2.9	-29.0	52.2
	T2 TSE DIXON SAG	119.2	141.4	45.9	56.4	73.3	85.0	18.7	22.9	16.0
	T1 TSE SAG	60.4	43.9	203.5	131.0	143.1	87.1	-27.3	-35.6	-39.1
	T1 TSE DF SAG	18.3	12.6	160.4	122.2	142.0	109.6	-31.2	-23.8	-22.8
	T1 TSE AX	35.1	17.5	125.0	56.1	89.9	38.6	-50.1	-55.1	-57.1
L-spine	T2 TSE SAG	78.1	53.1	39.6	18.0	38.4	35.1	-32.0	-54.5	-8.8
	T2 TSE STIR SAG	59.4	62.4	32.7	22.0	26.7	40.4	5.0	-32.7	50.9
	T1 TSE SAG	42.4	30.3	106.6	98.0	64.3	67.7	-28.4	-8.1	5.3
	T1 TSE DF SAG	39.8	36.2	53.9	68.8	14.0	32.6	-9.0	27.7	131.9
	T2 TSE AX	120.6	86.2	25.6	9.8	95.0	76.4	-28.5	-61.6	-19.6
	T2 TSE MSMA AX	115.7	40.7	27.4	7.7	88.3	33.0	-64.8	-71.8	-62.7

SUPPLEMENTAL TABLE 6. SNR, CNR AND PERCENTAGE CHANGE VALUES PER SEQUENCE PER PROTOCOL FOR SAR_{RT} AND SAR_{LOW}.

Head			C-spine		
<i>T1 SE Sag</i>	–		<i>T2 TSE Sag</i>	–	
<i>T1 SE Cor</i>	–		<i>T2 TSE STIR Sag</i>	TR:4000, FA:130	2/5
<i>T2 TSE Ax</i>	TR: 13500- 15500	1/5	<i>T1 TSE Sag</i>	TR:750, FA:120	4/5
<i>T2 TSE DF Ax</i>	–	3/5	<i>T1 TSE DF Sag</i>	TR:2500- 2700, FA:120-130	5/5
<i>Diffusion Ax</i>	TR:5500	2/5	<i>T2 TSE Ax</i>	TR:8000	1/5
<i>TOF Ax</i>	TR:55-70	3/5	<i>T2 SSFP-3D AX</i>	FA:45-47	5/5

T-spine			L-spine		
<i>T2 TSE Sag</i>	TR:4500	3/5	<i>T2 TSE Sag</i>	TR:4000- 4700	3/5
<i>T2 TSE STIR Sag</i>	TR:5000- 5500	4/5	<i>T2 TSE STIR Sag</i>	TR:4200	2/5
<i>T2 TSE DIXON Sag</i>	TR:4500- 5600	5/5	<i>T1 TSE Sag</i>	TR:700-720	2/5
<i>T1 TSE Sag</i>	TR:750-780	3/5	<i>T1 TSE Ax</i>	TR:700	3/5
<i>T1 TSE DF Sag</i>	–		<i>T2 TSE Ax</i>	TR:4500	3/5
<i>T1 TSE Ax</i>	TR:600-620	4/5	<i>T2 TSE MSMA Ax</i>	TR:4500	3/5

SUPPLEMENTAL TABLE 7. In situ parameter modification performed in some volunteers to reach whole body SAR of 0.1 W/kg and local-head SAR of 0.3 W/kg.